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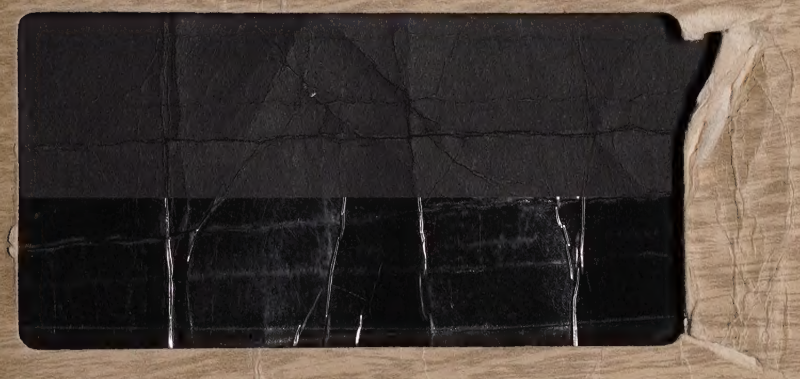


NEW LONDON INSTRUMENT CO. INC.

NEW LONDON, CONNECTICUT

INSTRUCTIONS
FOR
INSTALLATION & OPERATION
OF

FREQUENCY MODULATION MONITOR
TYPE 257A

MANUFACTURED BY:
NEW LONDON INSTRUMENT COMPANY, INC.
NEW LONDON, CONNECTICUT

WARNING

HIGH VOLTAGE

is used in the operation of

this equipment

Be careful not to contact high-voltage connections or any power connections when using this equipment. Turn off the power and discharge all high-voltage capacitors before making any test connections or doing any work inside the equipment.

1 - General Description

The Model 257A Frequency Modulation Monitor has been developed primarily for the calibration of FM signal generators in the frequency range from 20 to 1,000 megacycles. In addition, the instrument is also capable of performing the following operations:

a. Measurement of deviation of FM transmitters in the frequency range 20 to 1,000 mcs.

b. Measurement of modulation distortion (with external distortion analyzer) of FM signal generators and transmitters.

c. Measurement of FM noise and hum modulation of FM signal generators and transmitters in the specified frequency range.

d. Measurement of FM signal Generator and transmitter carrier shift due to modulation.

11 - SPECIFICATIONS

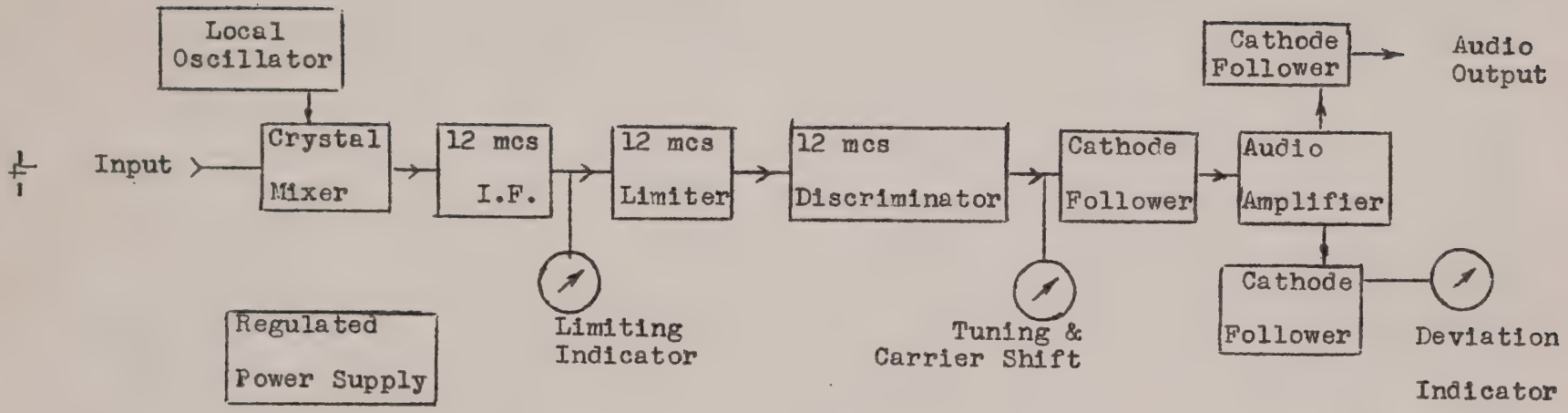
1. Electrical

Carrier Frequency Range:	20 - 1,000mc.
Frequency DeviationRanges:	0-20, 0-50, 0-100, 0-300, and 0-1,000 kc.
Frequency Deviation Accuracy:	± 5% of full scale deflection for modulation frequencies to 70 kc.
Audio Frequency Range:	Audio frequency response flat within ± 1.0db from 50-70,000 cps.
Carrier Shift Range:	0 to ± 250 kc.

Input Sensitivity:	Better than 10 mv from 20 to 500 mc and better than 20 mv from 500 - 1,000 mc measured from 50 ohm source.
Input Impedance:	100 ohms approximate.
Modulation Frequency Output:	1.2 volts adjustable ± 10% corresponding to full scale reading of each of the six deviation ranges.
Modulation Distortion:	Overal modulation distortion introduced by the modulation meter does not exceed 1% up to 300 kc deviation and 3% up to 1,000 deviation.
Noise and Hum:	The combined noise and hum output at the audio output terminals is more than 60 db below 100 kc deviation with a flat weighting across a noise band width of 20 kc.
AM Rejection:	The specified accuracy of indicated frequency deviation is maintained in presence of spurious amplitude modulation up to 30% for modulating frequencies below 70 kc.
Power Requirements:	Approximately 200 watts. 115/230 volts (switchable from the front panel) 50-70 cps.

2. Mechanical

Dimensions:	10½ x 19 x 14½ deep, relay rack mounting.
Weight:	60 pounds
Cabinet:	Rack mounted. Transit case available on order.



Block Diagram

Fig. 1

III - INSTALLATION AND OPERATION

1. Installation

This instrument is shipped completely equipped and ready for operation; no special adjustments are required. It is only necessary to plug the power plug into a source of 50 - 60 cycles, 105 - 125 volts power capable of supplying at least 200 watts, and to place the ON-OFF POWER switch in the ON position. If a 210 - 250 volts source is to be used, reverse the voltage plate on the front panel by removing the 2 screws that secure it. Take the plate off, move the switch bat to the other position, and replace the plate with the desired voltage side out. This will automatically assure the user that the proper connections have been made.

2. Controls and Their Function

Front Panel Controls

Control	Function
FREQUENCY RANGE Control	Selects local oscillator tank coil for tuning over any one of 5 ranges. 20 - 55 mcs 55 - 120 120 - 250 250 - 500 500 - 1,000
TUNING Control	Tunes local oscillator over each range.

Control	Function
DEVIATION RANGE Switch (S3)	Selects DEVIATION meter range. There are five range positions: 0 - 20 kc 0 - 50 0 - 100 0 - 300 0 - 1,000
TUNE ± 250 KC Switch (S4)	Selects CARRIER SHIFT meter range. In TUNE position the entire discriminator S-curve may be seen. In ± 250 KC position, the instrument is fine tuned for center frequency and the meter will then read 250 KC full scale.
CAL. ADJ. Control (R98)	Adjusts DEVIATION meter setting when calibrating.
AUDIO ADJ. Control (R103)	Adjusts AUDIO OUTPUT voltage ± 10% of its nominal value.
POWER ON Switch (S1)	Connects the monitor to AC power source when in ON position.
115-230V Switch (S2)	Switches transformer connections for 115 or 230V operation.

3. Operation

a. Preliminary

Set the front panel controls as follows:

Control	Function
DEVIATION RANGE Switch	TUNE position
TUNE ± 250 KC Switch	TUNE position
POWER Switch	Off

b. Starting

Connect the power cable to the A-C power source. Turn on the modulation monitor by throwing the POWER switch to the ON position. Allow one-half hour for warm-up.

CAUTION: Be sure reversible cover plate marking corresponds to line voltage being used.

1. Rotate the FREQUENCY RANGE switch to the desired range.
2. Rotate TUNING control until desired frequency is under hair-line on fiducial.
3. Connect unmodulated signal source to INPUT CONNECTOR.
4. Adjust TUNING control for zero indication on CARRIER SHIFT meter.
5. Rotate TUNE ± 250 KC switch to ± 250 KC position.
6. Readjust TUNING control for zero indication on CARRIER SHIFT meter.
7. Apply modulation to signal source.
8. Carrier shift may be read directly on CARRIER SHIFT meter.
9. Rotate DEVIATION RANGE switch to desired range and read deviation on DEVIATION meter. Always use range which gives highest upscale reading.

IV - THEORY OF OPERATION

1. RF Oscillator

RF Oscillator V1 is a shunt-fed Colpitts oscillator utilizing a 5675 pencil triode. The fundamental oscillator frequency is selected by rotating the FREQUENCY RANGE switch to the desired range and then setting the manually operated tuning control. The frequency of oscillation is determined by both sections of C2 and L3. The coils and pick-up loops for each range are mounted on a low-loss, thermally stable turret. Additional temperature compensation is obtained by means of C114, a bimetallic strip. The high frequency end of each band may be trimmed by means of a special tuning slug (C115), whose shaft is available at the rear of the RF enclosure. The pick-up coils for each range are adjusted to provide optimum mixer-crystal injection voltage over the range, and hence the conversion efficiency is optimized and kept essentially flat. The fundamental frequency range of the oscillator is 30 to 520 mcs. Conversion on the top range (500 to 1,000 mcs) is obtained by utilizing the second harmonic of band 4. The dial is calibrated on all bands in terms of signal frequency.

2. Crystal Mixer

The crystal mixer has been designed to accommodate RF up to 1,000 mcs. Local oscillator voltage is injected through a 150 ohm resistor to provide separation from the signal source and is adjusted for 0.5 ma crystal current on all ranges. Optimum conversion gain (-6db) is thus obtained on fundamental mixing. The optimum conversion gain for second harmonic mixing is approximately 2-3 db worse. A built-in bypass capacitor (C1) at the IF take-off point returns the signal frequency to ground.

3. Intermediate Frequency Amplifier

The IF amplifier is a high gain, wide-band system operating at a center frequency of 12 mcs. It employs five critically-coupled, double-tuned stages; (V2, V3, V4, V5, and V6) and has an overall 3db bandwidth of approximately 3 mcs. Saturation is prevented by a unique delayed AVC circuit. This circuit compares the detected RF output of the last IF to a DC reference level and the first four tubes receive additional negative grid bias whenever the preset DC level is exceeded.

4. Limiters

Two double-tuned, critically-coupled limiter stages (V7, V8), are employed to obtain the required AM rejection characteristics. Crystal diodes CR-3 and CR-4 are used to improve the rectification efficiency of the limiter grid circuits. V9 is a wideband driver amplifier which raises the limiter output to a high level for driving the discriminator. Visual indication

of limiting is provided by a 0-200 UA meter which is deflected by the control grid current of the first limiter tube. R38 sets this meter to the beginning of the red limiting region when an input of 5 mv is provided at the INPUT jack of the modulation meter.

5. Discriminator

The discriminator is a modified Foster-Seely type which is enclosed along with all of its components in T9. The networks consisting of R54 and C64, R55 and C70, R56 and C73, and R57 and C74 are used to obtain the desired linear wide-peak separation characteristics. Center frequency trimmer C71 and peak separation trimmer C67 are available for adjustment at the top of T9. The relatively small diode load resistors R60 and R61 are necessitated by the wide audio response of the system. Carrier shift indication is provided on sensitive zero-center meter whose deflection is proportional to the DC voltage at Pin 3 of the discriminator transformer. Two ranges are provided by S4. The first range displays the entire S-curve; the second range indicates carrier shifts of $\pm$ 250 KCs. R118 is a calibration potentiometer for the $\pm$ 250 KC range.

6. Audio Amplifier

The audio amplifier consists of four RC coupled stages (V10, V11, V12, and V13) and is characterized by cathode follower input and output isolation, extremely low distortion, and a very high degree of stabilization obtained both in the individual unbypassed cathodes and by an overall feedback loop. The amplifier is insensitive to tube replacement and plate voltage changes. Separate cathode followers are used to drive the deviation indicator and to supply audio at the output terminals at an impedance of approximately 1400 ohms. The deviation range switch S3 is located on the low impedance side of cathode follower V10 to allow mounting on the front panel and minimize hum pickup. The deviation meter M-3 is driven by cathode follower V13 through a linear diode detector consisting of C96, R97, CR-7, and R105. R98 is a calibrating potentiometer in series with M-3.

7. Power Supply

The power supply utilizes a full wave bridge rectifier circuit and two stages of capacitor input filtering to provide an unregulated voltage of 240 volts for the plates of the IF and limiter stages. A regulated output of 195 volts is provided for all remaining tube elements. The regulator consists of a series tube (V15), a DC amplifier (V16), and a voltage reference tube (V17). The hum level is of the order of 1-2 millivolts. The filaments of V1 and V13 are regulated by means of the series regulator V14, for additional stability. The regulated output voltage is set by means of R116. The primary of the supply is so arranged that the unit may be operated from either 115V or 230V AC source. A reversible cover plate on the front panel is arranged so that switch S2 is in the appropriate position when the marking on the plate agrees with the line voltage being used.

V - ALIGNMENT AND ADJUSTMENT

1. Alignment Procedures

   a. When any critical circuit in the Modulation Meter is repaired or altered, an alignment check is required. If a circuit is found to need alignment, follow the procedures described in the following paragraphs. Before starting, remove the dust cover from the Modulation Meter. Refer to Figures 3, 4, and 5 for alignment points. Allow 1/2 hour for instrument warm-up before making any adjustments. When additional test equipment is used, allow a warm-up period for this equipment as prescribed in the appropriate instruction manual.

   b. When aligning IF or discriminator transformers be sure to use a non-metallic tuning screwdriver.

   c. Conduct the test in a shielded enclosure. If a shielded room is not available, make the alignment in an area free from stray RF and electrical disturbances.

   d. To assure stable functioning of all test equipment used, maintain a regulated line voltage to the test area.

   e. Follow the alignment procedures in sequence.

2. Adjusting Regulated Supply

   Adjustment of the DC voltage (195 volts) is required before any other alignment is begun.

   a. Connect a DC voltmeter (0-300 volt range) between ground and Pin 6 of V15.

   b. Turn the POWER switch to ON.

   c. Adjust potentiometer R116 (volts Adj.) for a meter reading of 195 volts.

   d. Disconnect the voltmeter.

   NOTE: Power source should be 115VAC, 60 cps.

3. Alignment of IF Amplifier

   The IF Amplifier is best aligned with a swept-frequency signal generator as follows:

   a. Disconnect cable W-3 from the mixer assembly.

b. Set DEVIATION RANGE and CARRIER SHIFT RANGE switches to TUNE position.

c. Connect swept-frequency signal generator to INPUT jack.

d. Set signal generator to center frequency of 12 megacycles and 6 megacycle sweep-width.

e. Connect horizontal terminals of cathode ray oscilloscope to sweep voltage of signal generator.

f. Connect vertical terminals of CRO to Pin 7 of V6 using shielded cable and probe as in Fig. (5-1).

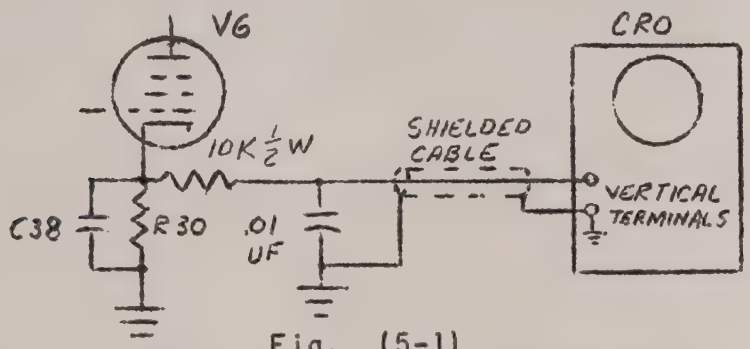


Fig. (5-1)

g. Adjust CRO controls to obtain IF response curve.

h. Loosely couple a grid dip oscillator (or marker generator) set at 12 mcs to V6. A marker should appear at the approximate center of the response curve.

i. Adjust the marker to the 3db points of the response curve. These points fall approximately at 10.5 mcs and 13.5 mcs. (See Fig. 5-2).

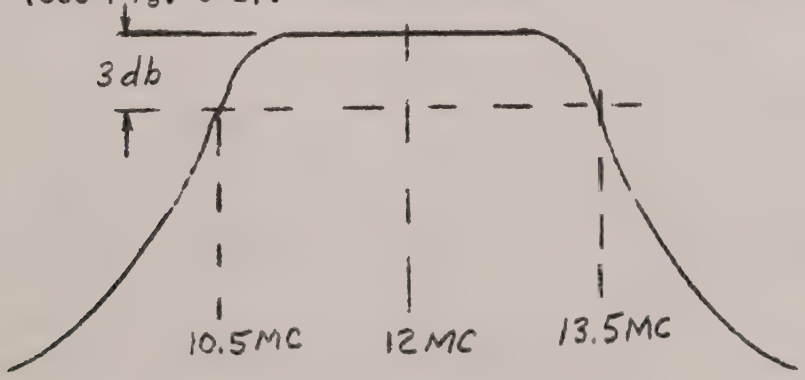


Fig. (5-2)

Note: If the overall response curve is substantially out of alignment, a stage-by-stage procedure will have to be followed. This is a well-known procedure and is outlined in detail in Volume 18, MIT Radiation Laboratory Series, Pages 318-321.

4. Alignment of Limiter Stages

   a. Repeat steps a-d of IF alignment procedures.

   b. Connect vertical terminals of CRO to cathode pin (5) of V9 through cable and probe as in Fig. (5-2) of IF alignment procedures. CAUTION! Keep leads short!

   c. Adjust CRO controls to get response curve on CRO face. Increase level of swept-frequency signal generator until limiting occurs as indicated by sudden widening of the response curve.

   d. Loosely couple a grid dip oscillator (or marker generator) to V9. Check location of markers at 10, 12 and 14 mcs. The response curve should be flat within about ± 1 db in this region. (See Fig. 5-3).

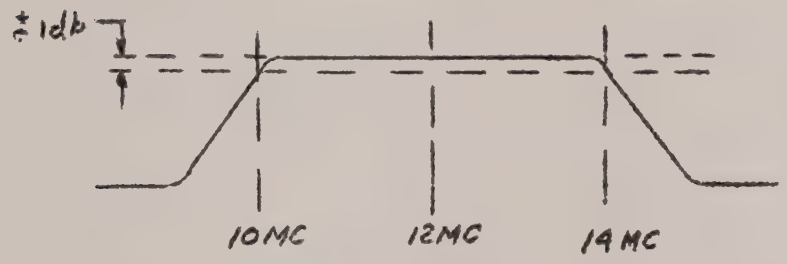


Fig. (5-3)

   e. If the response curve is not reasonably close to Fig. (5-3), adjust trimmers of T6 and T7 to obtain proper curve. Start with T7 and work back to T6.

   f. Disconnect swept-frequency signal generator and CRO probe.

   g. Connect cable W-3 to mixer assembly.

5. Alignment of Discriminator

   a. Repeat steps a-d of IF alignment procedures.

   b. Connect vertical terminals of CRO to ground and junction of R62 and R63 (through 10K, 1/2 W resistor).

   c. Adjust signal level until limiting occurs as indicated by rapid decrease of noise level on CRO.

   d. Adjust CRO controls to obtain response curve which covers about 2/3 of the screen.

   e. Loosely couple a grid dip oscillator (or marker generator) to the 10K probe and check location of 10, 12, and 14 mc markers. These points should comply with Fig. (5-4).

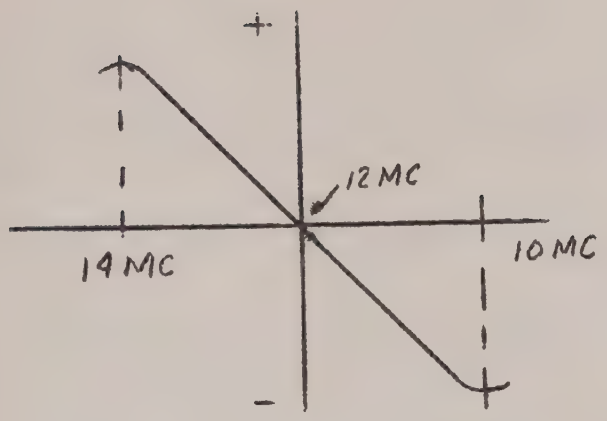


Fig. (5-4)

f. If the discriminator is out of alignment, adjust C-67 for proper peak separation and C-71 for proper center frequency.

g. Follow CARRIER SHIFT calibration procedure for precise discriminator alignment.

h. Disconnect swept-frequency signal generator and CRO probe.

i. Connect cable W-3 to mixer assembly.

j. Connect low distortion FM signal generator to INPUT jack.

k. Connect distortion analyzer to AUDIO OUTPUT terminals.

l. Apply 50 KC deviation (50 mc carrier frequency, 1 KC audio frequency) from signal generator. Measured distortion should be 0.5% or less for proper alignment.

m. Disconnect FM signal generator and distortion analyzer.

6. Adjustment of AVC Delay

a. Connect 50 Ohm Signal Generator (set to 50 mcs) to INPUT jack of the Modulation Meter. Set OUTPUT of generator at 5 mv.

b. Tune in signal on Modulation Meter.

c. Attach DC VOLTMETER (0-10V Range) to center tap of R128.

d. Attach vacuum tube voltmeter (0-10VAC Range) to Pin 3 of T-6 and read signal level.

e. Set voltage on DC meter to same level as in previous step by adjusting R128.

f. Disconnect signal generator and voltmeters.

7. Carrier Shift Meter Calibration

a. Disconnect cable W-2 from mixer assembly and connect to CW signal generator, covering the range 10 to 14 megacycles.

b. Beat external signal generator against crystal calibrator at 12 mcs. (Use 1 mc harmonics of calibrator.)

c. Switch TUNE ± 250 KC switch to ± 250 KC position. The CARRIER SHIFT meter should read zero. If it does not read zero, adjust C-71 slightly.

d. Set external signal generator to 12.250 mcs by zero beating against 250 KC harmonics of crystal calibrator.

e. Adjust R113 for full scale deflection of CARRIER SHIFT meter (± 250 KC).

f. Set external signal generator to 11.750 mcs by zero beating against 250 KC harmonics of crystal calibrator.

g. CARRIER SHIFT meter should read -250 KC. If it does not, adjust C-67 slightly and repeat steps b through f.

h. Reconnect cable W-2 to mixer assembly.

8. Deviation Meter Calibration

a. Connect Modulation Meter INPUT to FM signal generator which is modulated by external audio oscillator.

b. Connect frequency counter to audio oscillator.

c. Set audio oscillator to 4640 cps using counter.

d. Set FM signal generator to 50 mcs.

e. Connect panoramic indicator to signal generator output and obtain indication of carrier on screen.

f. Increase audio oscillator input until carrier goes through third null. (This represents 40 KC deviation.)

g. Disconnect panoramic indicator.

h. Rotate DEVIATION RANGE SWITCH to 50 KC position and note reading on DEVIATION METER.

i. If the METER does not read correctly, turn CAL ADJ. potentiometer (R98) until pointer indicates 40 KC deviation.

NOTE: This calibration may be performed at any other carrier frequency, audio frequency, or deviation.

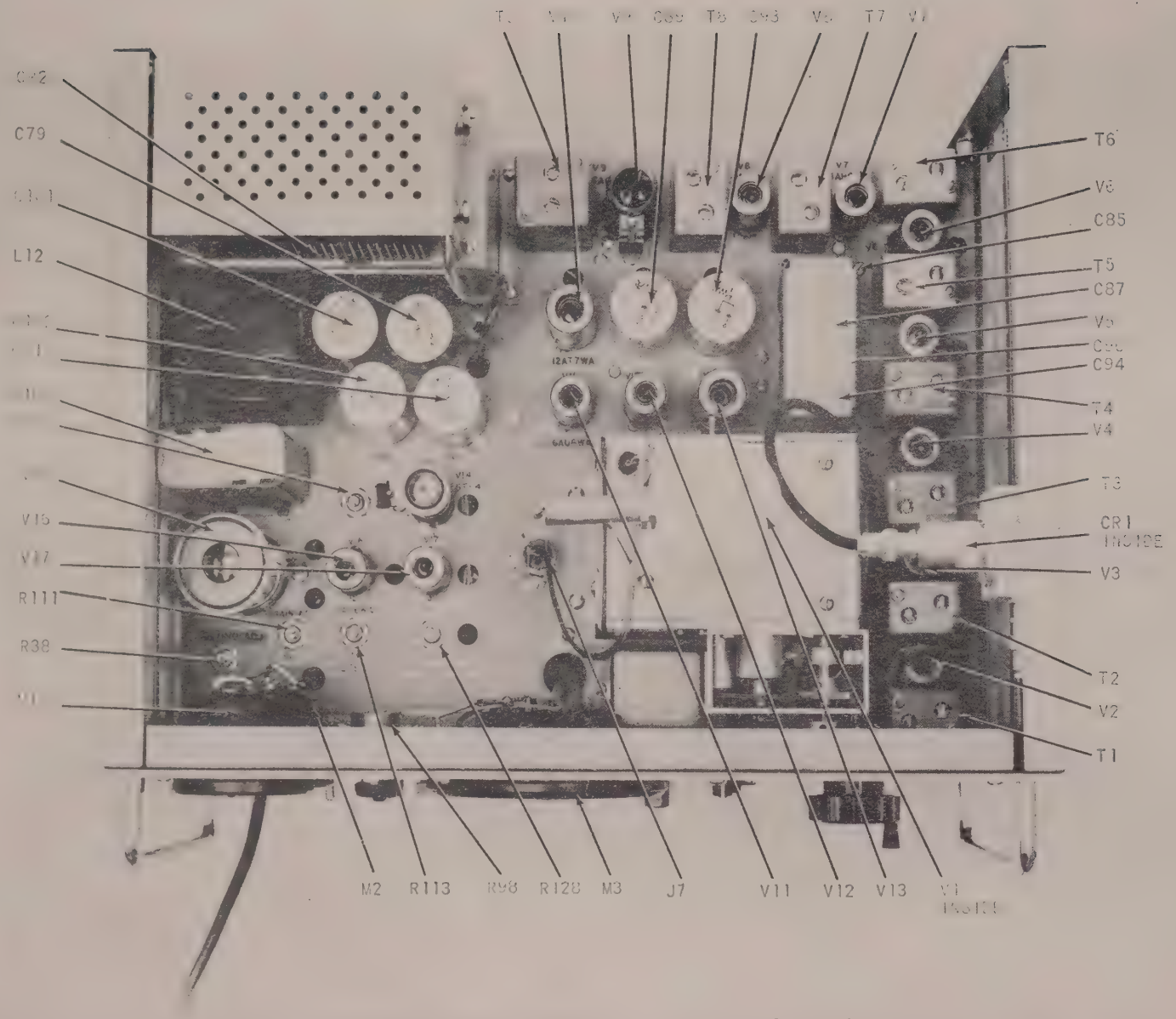


Figure 3. Modulation Meter Top View of Chassis

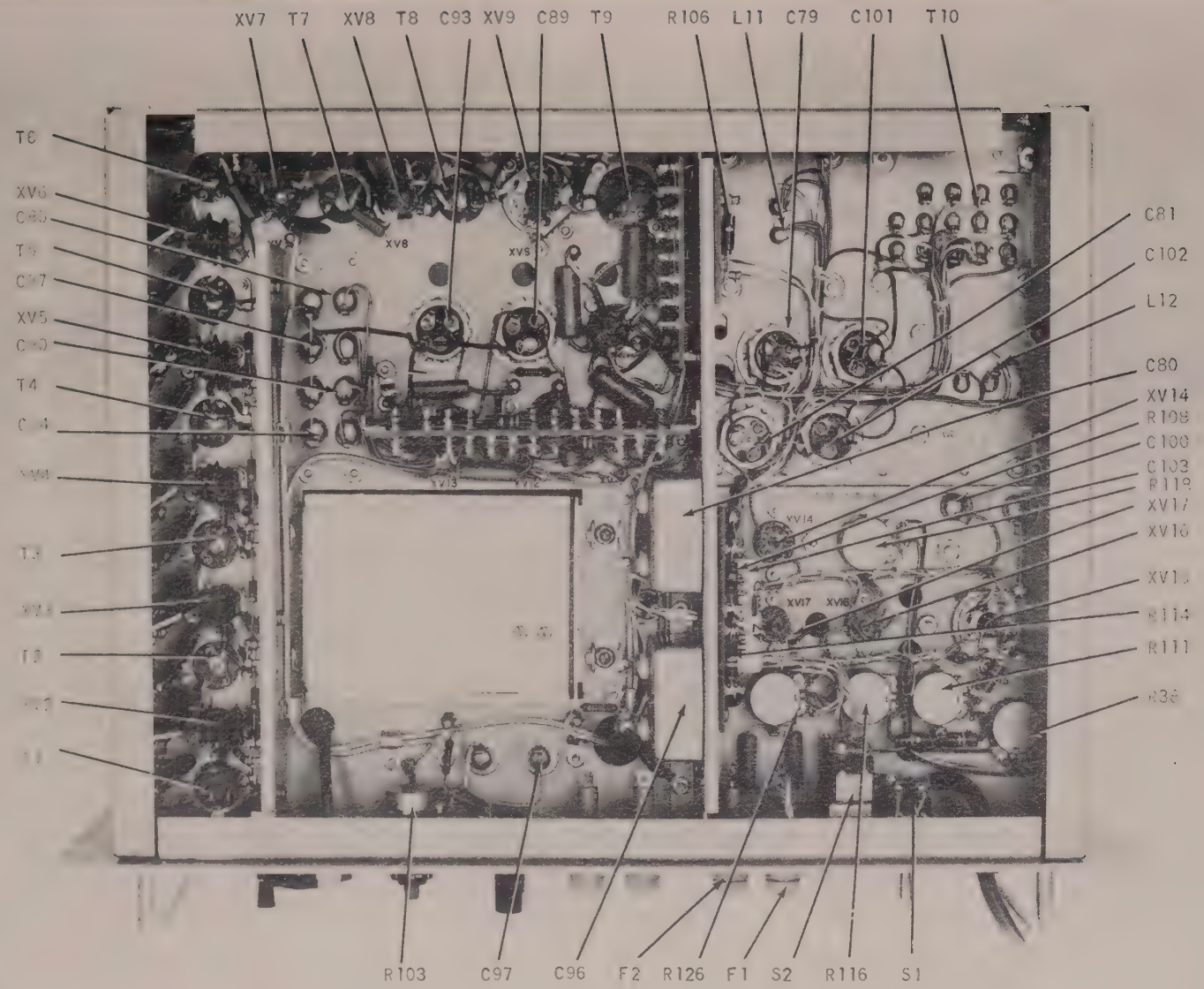


Figure 4. Modulation Meter Bottom View of Chassis

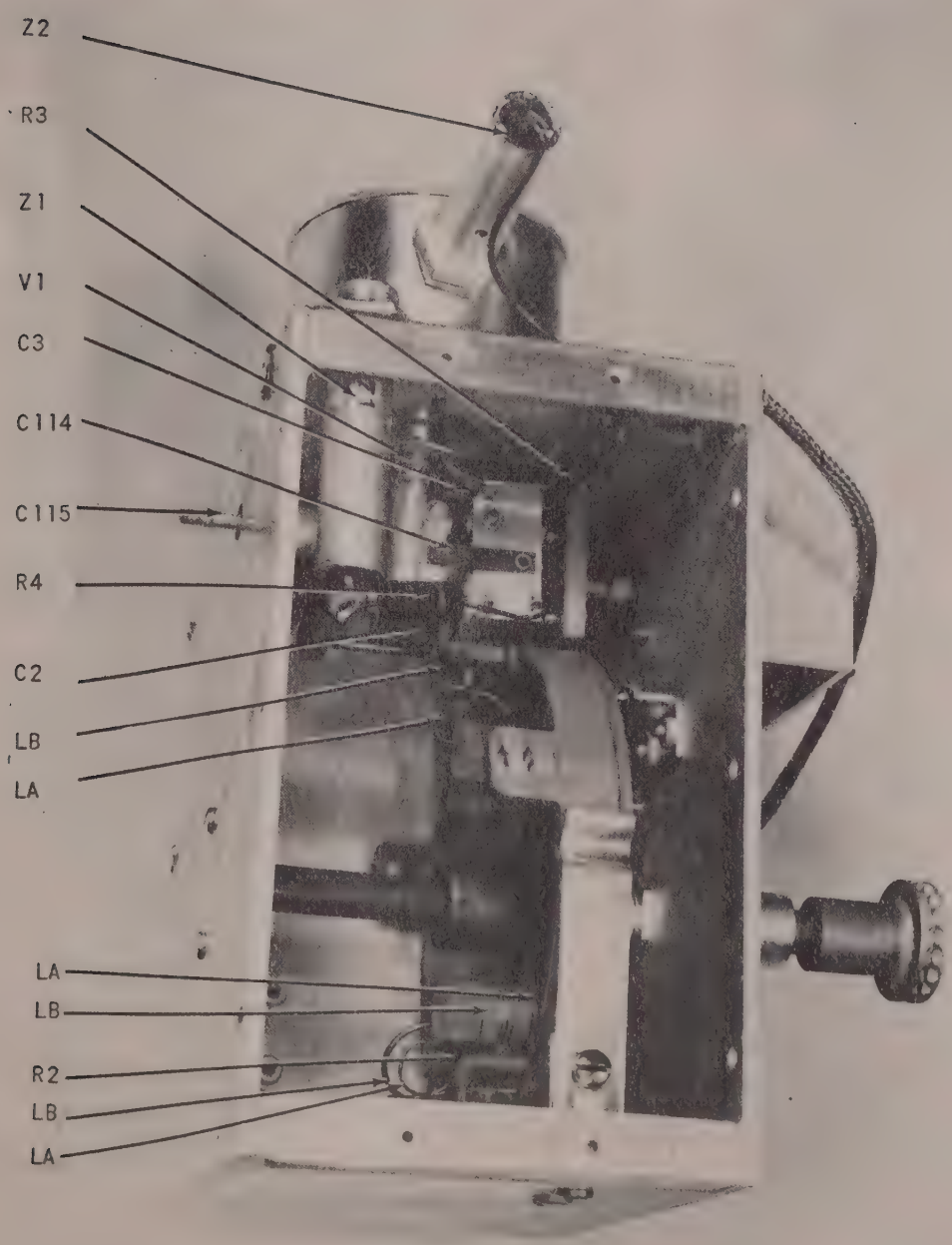


Figure 5. Modulation Meter R-F Oscillator Assembly

VI - RESISTANCE TO GROUND

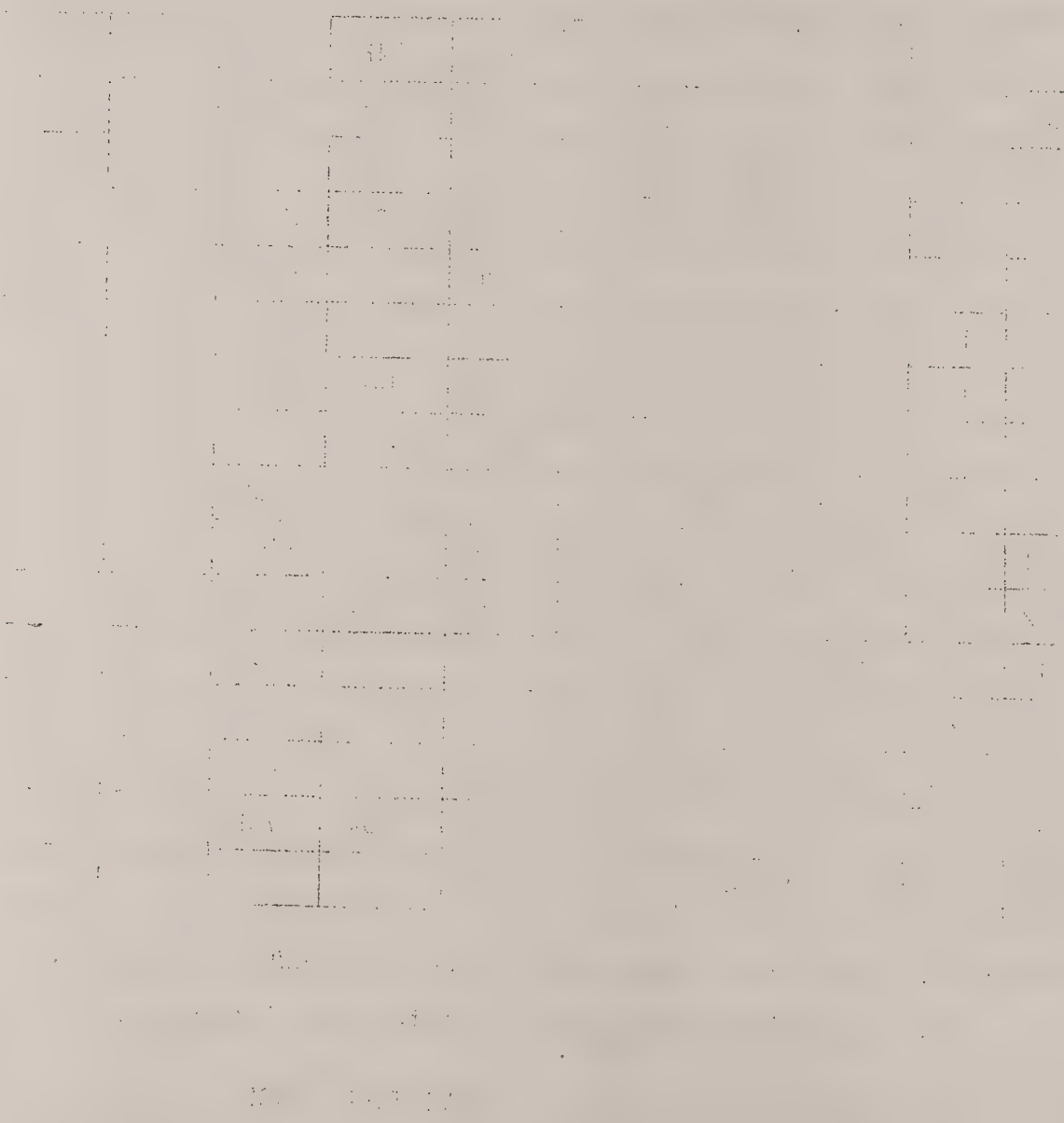
Pins

	1	2	3	4	5	6	7	8	9
V2	62K	47	0	0	180K	34K	47		
V3	62K	47	0	0	180K	34K	47		
V4	62K	47	0	0	180K	34K	47		
V5	70K	150	0	0	150K	80K	150		
V6	0	150	0	0	180K	80K	150		
V7	10K	0	0	0	170K	15K	0		
V8	15K	0	0	0	170K	14K	0		
V9	0	0	∞	50	330	12.5K	0	200K	
V10	15K	470K	11K	∞	∞	25K	470K	120	∞
V11	470K	140	∞	∞	44K	18K	140		
V12	470K	160	∞	∞	35K	18K	160		
V13	13K	470K	12K	∞	∞	17K	100K	6K	0
V14	∞	0	0	∞	∞	∞	0	0	0
V15	500K	180K	11K	500K	180K	11K	∞	∞	
V16	50K	70K	∞	∞	50K	90K	70K		
V17	70K	0	∞	0	70K	∞	0		

Note: 1. Resistance measurements made with POWER switch OFF.

2. ∞ indicates very high (greater than 5 megohms) resistance on meter.

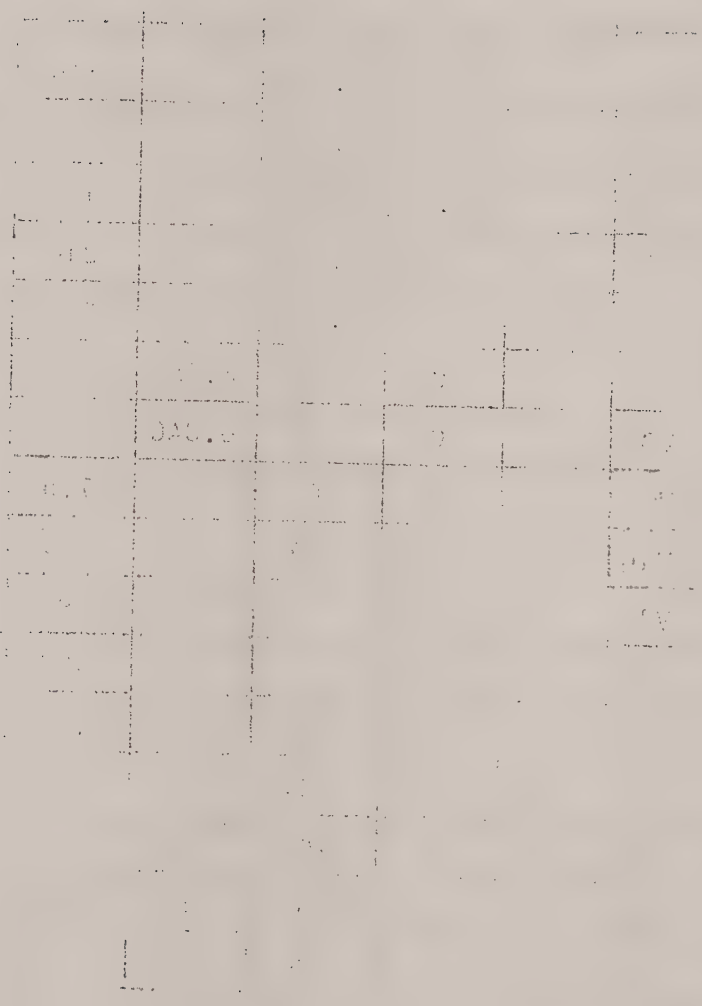
3. CARRIER SHIFT RANGE and DEVIATION RANGE switches in TUNE position.



V11 - VOLTAGES TO GROUND

	Pins								
	1	2	3	4	5	6	7	8	9
V2	0	0.8	6.3AC	0	165	120	0.8		
V3	0	0.8	6.3AC	0	175	110	0.8		
V4	0	0.8	6.3AC	0	170	110	0.8		
V5	0	1.1	6.3AC	0	210	120	1.1		
V6	0	1.2	6.3AC	0	210	110	1.2		
V7	0	0	0	6.3AC	105	75	0		
V8	0	0	0	6.3AC	100	100	0		
V9	0	0	0	0	7.5	190	6.3AC	225	
V10	175	56	57	13	13	135	0	1	3
V11	0	0.65	12	12	90	80	0.65		
V12	0	1.3	12	12	120	85	1.3		
V13	190	70	74	6.3AC	6.3AC	160	40	42	0
V14	NC	13	13AC	NC	NC	NC	NC	6.3AC	6.3AC
V15	175	260	200	175	260	200	150	150	
V16	88	88	150	150	175	120	88		
V17	88	0	NC	0	88	NC	0		

Notes:
1. All voltage measurements made with 20,000 Ohms-Per-Volt DC Multimeter and 1,000 Ohms-Per-Volt AC Multimeter.
2. NC indicates no connection.
3. CARRIER SHIFT and DEVIATION RANGE switches in TUNE position.
4. Line voltage switch set to 115 VAC.



VIII - TROUBLE SHOOTING CHART

SYMPTOM	PROBABLE TROUBLE	CORRECTION
1. Line cord connected to power source and POWER switch is in ON position. Indicator lamp fails to light.	Blown fuse F1 and/or F2	Replace blown fuse. If fuse blows again, check the primary winding and all filament windings of T10. Check for a shorted RF bypass capacitor in filament circuits. Check for a filament-to-cathode short in the tubes whose cathodes are grounded directly.
	Open filament winding (terminals 7 and 8) or primary winding (terminals 1 and 2, 3 and 4) of T10	Replace T10
	Defective POWER switch or power cable	Replace S1, S2, or power cable
	Defective indicator lamp I1	Replace lamp
2. Fuse F1 and/or F2 blow when POWER switch is set to ON position.	Shorted filter capacitor C100, C101, or C102	Replace defective capacitor
	A short in any of the DC circuits in the Modulation Meter	Make resistance measurements at the tube socket of all tubes in the modulation monitor
3. POWER Switch in ON position. Unmodulated input signal connected. Limiting indicator does not read for any position of FREQUENCY RANGE switch or tuning control.	Defective mixer crystal CR-1	Replace CR-1
	Defective local oscillator tube V1	Replace V1
	Defective IF amplifier tube, V2 through V6	Replace defective tube
	Defective limiter tube V7	Replace V7

SYMPTOM	PROBABLE TROUBLE	CORRECTION
	A defective component in the circuitry of the limiting indicator.	Check R37, C49, R38 and M1
	A defective cable connection or cable in mixing circuitry	Check cables W1, W2, and W3 and associated connectors J1, J2, J3, J4, J5 and P2, P3, P4, and P5
	A defective component in the circuitry of the above mentioned tubes	Make resistance and voltage measurements at the tube socket of all tubes mentioned
	Defective oscillator contacts	Repair or replace contacts
4. POWER switch in ON position. Unmodulated signal applied to J1. CARRIER SHIFT meter does not respond as tuning control is varied.	Check all symptoms under (3)	Same as correction under (3)
	Defective driver tube V9	Replace V9
	Defective discriminator diodes CR5 and/or CR6	Replace CR5 and/or CR6
	Defective switch S4	Replace S4
	Shorted meter M2	Check meter and associated circuitry
	A defective component in circuitry of V9	Make resistance and voltage measurements at the tube socket of V9
5. Power ON. FM signal applied to J1. All meters read except the DEVIATION METER for any setting of the DEVIATION RANGE switch	Defective audio amplifier tube V10, V11, V12, or V13	Replace defective tube
	Defective crystal CR7	Replace CR7
	Open or shorted meter M3	Replace meter M3

	SYMPTOM	PROBABLE TROUBLE	CORRECTION
		A defective component in the circuitry of the audio amplifier tubes	Make resistance and voltage measurements at the tube sockets of all audio tubes
6.	POWER ON. FM signal applied to J1. All meters read but there is no output across audio binding posts.	1/2 of V13 defective	Replace V13
		A defective component in the circuitry of 1/2 V13	Make resistance and voltage measurements at the appropriate pins of V13
7.	POWER ON. FM signal applied to J1. All meters read except the LIMITING indicator.	R37 open	Replace R37
		Shorted bypass capacitor C49	Replace C49
		Defective potentiometer R38	Replace R38
		Defective meter M1	Replace M1
8.	POWER ON. FM signal applied to J1. All meters read except the CARRIER SHIFT meter as TUNING control is varied. CARRIER SHIFT RANGE switch in any position	R62 or R63 open	Replace R62 and/or R63
		C76 or C77 shorted	Replace C76 and/or C77
		Defective meter M2	Replace M2
		Defective switch S4	Replace S4
9.	DEVIATION meter does not indicate proper deviation on any range.	Deviation calibration potentiometer R98 misadjusted	Adjust R98 (See alignment procedures)
		A defective component on S3	Replace defective component
10.	CARRIER SHIFT meter does not indicate correctly when RANGE switch is in ± 250 KC position.	Calibration potentiometer R118 misaligned	Adjust R118 (See alignment procedures)
11.	LIMITING meter does not remain in red zone for inputs from 5 - 500 mv on any frequency range.	AVC circuitry inoperative or misaligned	Check all components associated with AVC circuit. Adjust AVC Delay R128 (See alignment procedure)

TABLE OF REPLACEABLE PARTS

Reference Symbol	Name of Part & Description	Location of or Function of Part
C2	CAPACITOR, variable: air; 3.5 to 31.5 uuf capacity 3 in. lg overall Hammarlund Mfg. Co. Part No. VU-30 modified	Oscillator tuning
C4,C5,C12 C13,C20,C21 C28,C29,C36, C37,C46,C47, C54,C55,C61, C62,C67	CAPACITOR, variable: ceramic; 4.5 to 25.0 uuf JAN type CV11A250	IF trimmers
C6,C7,C8,C9 C11,C14,C15, C16,C17,C19, C22,C23,C24, C25,C27,C30, C31,C32,C33, C35,C38,C39, C40,C41,C42, C43,C45,C49, C50,C51,C53, C57,C58,C59, C63,C64,C65, C66	CAPACITOR, fixed: disc ceramic; 10,000 uuf, 500 VDCW MIL type CK63Y103Z	RF Bypass
C10,C18,C26, C34,C44,C52, C60,C109, C110,C111, C112	CAPACITOR, fixed: disc ceramic; 1,000 uuf, 500 VDCW MIL type CK61Y102Z	DC blocking capacitor
C48,C56	CAPACITOR, fixed: mica; 100 uuf, 500 VDCW JAN type CM20C101J	DC blocking capacitor
C68	CAPACITOR, fixed: ceramic; 27 uuf, 500 VDCW JAN type CC20BF270F	Coupling capacitor
C69,C70, C72	CAPACITOR, fixed: ceramic; 10 uuf, 500 VDCW JAN type CC20BF100K	Discriminator network
C71	CAPACITOR, variable: ceramic; 1.5 to 7.0 uuf JAN type CV11A070	Discriminator trimmer

TABLE OF REPLACEABLE PARTS

Reference Symbol	Name of Part & Description	Function or Location of Part
C73,C74	CAPACITOR, fixed: ceramic; 15 uuf, 500 VDCW JAN type CC20BF150F	Discriminator network
C76,C77	CAPACITOR, fixed: paper; .25 mfd, 100 VDCW Cornell-Dubilier Part No. TWC1D22G4P	By-pass
C78,C82, C84,C88	CAPACITOR, fixed: paper; 0.03 mfd, 600 VDCW Cornell-Dubilier Part No. CUB653	Grid-coupling
C79,C81, C89,C93, C101,C102	CAPACITOR, fixed: electrolytic; 20-20 mfd, 450 VDCW JAN type CE42F200R	De-coupling
C80,C96	CAPACITOR, FIXED: paper; 2 uf, 400 VDCW JAN type CP54B1EB205V	Coupling
C83	CAPACITOR, fixed: mica; 500 uuf, 500 VDCW JAN type CM20C750J	Audio HF compensating
C85,C87, C90,C94	CAPACITOR, fixed: paper; 1 uf, 400 VDCW JAN type CP61B1EE105V	De-coupling
C92	CAPACITOR, fixed; paper; .002 uf, 400 VDCW	
C95, C98,C99	CAPACITOR, fixed; paper; .01 mfd, 600 VDCW Cornell-Dubilier Part No. CUB651	C95 - Grid coupling C98,C99 - By-Pass
C97	CAPACITOR, fixed: paper; 2 uf, 100 VDCW JAN type CP55B1EB205V	Audio Output Coupling
C100	CAPACITOR, fixed: paper; 4 uf, 600 VDCW JAN type CP70B1EF405K	B+ filter
C103	CAPACITOR, fixed: paper; .5 mfd, 400 VDCW Aerovox Corp. Part No. Aerolite P123NGP	De-coupling

TABLE OF REPLACEABLE PARTS

Reference Symbol	Name & Description of Part	Function or Location of Part
C104	CAPACITOR, fixed: mica; 150 uuf, 500 VDCW JAN type CM20C151J	Fixed tuning capacitor for T1
C105,C106, C107,C108	CAPACITOR, fixed: ceramic; 100 uuf, 500 VDCW JAN type CC26CH101K	AVC de-coupling
C113	CAPACITOR, fixed: ceramic; 5 uuf, 500 VDCW JAN type CC21CH050K	AVC coupling capacitor
C114	CAPACITOR, temperature compensating; 7/8 in. lg, 3/16 in. wide, 0.023 in. thick NLIC Dwg No. 153-A-262	Oscillator temp compensating capacitor
R1	RESISTOR, fixed: film; 150 ohms ± 1%, 1/4 Watt, Mepco, Inc. Part No. C10-150	Oscillator de-coupling
R3	RESISTOR, fixed: composition; 47,000 ohms ± 10%, 1/2 Watt, JAN type RC20BF473K	Oscillator grid leak
R4	RESISTOR, fixed: composition; 6800 ohms ± 10%, 2 Watt, JAN type RC41BF682K	Oscillator plate dropping
R5,R8,R9, R11,R14,R15, R17,R20,R21, R23,R27,R34	RESISTOR, fixed: composition; 2700 ohms ± 10%, 1/2Watt, JAN type RC20BF272K	B+ dropping
R6,R12, R18,R49	RESISTOR, fixed: composition; 47 Ohms ± 10%, 1/2 Watt JAN type RC20BF470K	Cathode resistor
R7,R13,R19, R39,R40,R44, R80	RESISTOR, fixed: composition; 22,000 Ohms ± 10% , 1 Watt JAN type RC30BF223K	Screen supply resistor
R10,R16, R22,R28,R35	RESISTOR, fixed: composition; 470 Ohms ± 10% 1/2 Watt JAN type RC20BF471K	De-coupling
R24, R30	RESISTOR, fixed: composition; 150 Ohms ± 10%, 1/2 Watt JAN type RC20BF151K	Cathode resistor V5 & V6

TABLE OF REPLACEABLE PARTS

Reference Symbol	Name of Part & Description	Function or Location of Part
R25,R32, R114	RESISTOR, fixed: composition; 68,000 Ohms ± 10%, 1 Watt, JAN type RC30BF683K	Screen supply dropping and regulator bleeder
R26,R29,R33, R36,R46,R48	RESISTOR, fixed: composition; 2200 Ohms ± 10%, 1/2 Watt, JAN type RC20BF222K	Plate and screen load resistors
R31	RESISTOR, fixed: composition; 120 Ohms ± 10%, 2 Watt, JAN type RC40BF121K	De-coupling
R37,R119, R121,R123, R125	RESISTOR, fixed: composition; 10,000 Ohms ± 10%, 1/2 Watt, JAN type RC20BF103K	Grid leak AVC de-coupling
R38	RESISTOR, variable: composition; 250 Ohms ± 10%, 1/4 Watt, JAN type RV2ATSA251A	Limiting meter adjustment
R41	RESISTOR, fixed: composition; 1800 Ohms ± 10%, 1/2 Watt, JAN type RC20BF182K	V7 plate load
R42,R47	RESISTOR, fixed: composition; 12,000 Ohms ± 10%, 2 Watt, JAN type RC40BF123K	V7,V8 plate supply resistor
R43	RESISTOR, fixed: composition; 15,000 Ohms ±, 1/2 Watt, JAN type RC20BF153K	V8 grid bias
R45	RESISTOR, fixed: composition; 15,000 Ohms ± 10%, 2 Watt, JAN type RC40BF153K	V8 screen supply resistor
R50	RESISTOR, fixed: composition; 33 Ohms ± 10%, 1 Watt, JAN type RC30BF330K	V9 cathode resistor
R51	RESISTOR, fixed: composition; 6800 Ohms ± 10%, 2 Watt, JAN type RC40BF682K	V9 screen supply resistor
R53	RESISTOR, fixed: composition; 1,000 Ohms ± 10%, 2 Watt, JAN type RC40BF102K	V9 plate supply resistor

TABLE OF REPLACEABLE PARTS

Reference Symbol	Name of Part & Description	Function or Location of Part
R54,R55, R56,R57, R104	RESISTOR, fixed: film; 3300 Ohms ± 1%, 1/2 Watt, MIL type RN15R3301F	Voltage divides network discriminator & audio output
R58,R59	RESISTOR, fixed: film; 500,000 Ohms ± 1%, 1/2 Watt, MIL type RN15R5003F	Discriminator crystal diode equalizers
R60,R61	RESISTOR, fixed: film; MIL type RN15R1002F 10,000 Ohms ± 1%, 1/2 Watt	Diode load resistor
R62	RESISTOR, fixed: film; 680,000 Ohms ± 1%, 1/2 Watt, MIL type RN20R6803F	Carrier shift series resistor
R63	RESISTOR, fixed: film; 33,000 Ohms ± 1%, 1/2 Watt, MIL type RN20R4702F	Carrier shift metering circuit
R64,R75,R76, R85,R94,R113	RESISTOR, fixed: composition; 470,000 Ohms ± 10%, 1/2 Watt, JAN type RC20BF474K	Grid returns
R65	RESISTOR, fixed: composition; 100 Ohms ± 10%, 1/2 Watt, JAN type RC20BF101K	V10 cathode resistor
R66,R69, R79	RESISTOR, fixed; composition; 10,000 Ohms ± 10%, 1 Watt, JAN type RC30BF103K	V10 cathode load, decoupling and plate load
R67,R87, R88	RESISTOR, fixed: composition; 3,300 Ohms ± 10%, 1 Watt, JAN type RC30BF332K	Plate de-coupling
R68	RESISTOR, fixed: composition; 1000 Ohms ± 10%, 1 Watt, JAN type RC30BF102K	V10 plate supply dropping
R70	RESISTOR, fixed: film; 120 Ohms ± 1%, 1/2 Watt, MIL type RN20R1200F	Deviation range
R71	RESISTOR, fixed: film; 280 Ohms ± 1%, 1/2 Watt, MIL type RN20R2800F	Deviation range

TABLE OF REPLACEABLE PARTS

Reference Symbol	Name of Part & Description	Function or Location of Part
R72	RESISTOR, fixed: film; 800 Ohms ± 1%, 1/2 Watt, MIL type RN20R8000F	Deviation range
R73	RESISTOR, fixed: film; 1200 Ohms ± 1%, 1/2 Watt, MIL type RN20R1201F	Deviation range
R74	RESISTOR, fixed: film; 3600 Ohms ± 1%, 1/2 Watt, MIL type RN20R3601F	Deviation range
R77	RESISTOR, fixed: film; 100 Ohms ± 1%, 1/2 Watt, MIL type RN20R1000F	Feedback resistor
R81	RESISTOR, fixed: composition; 120 Ohms ± 10%, 1/2 Watt, JAN type RC20BF121K	V11 cathode
R82	RESISTOR, fixed: composition; 1,000 Ohms ± 10%, 2 Watt, JAN type RC40BF102K	
R83,R84, R91,R92	RESISTOR, fixed: compsoition; 27,000 Ohms ± 10%, 1 Watt, JAN type RC30BF273K	V11 screen bleeder
R86	RESISTOR, fixed: film; 51.1 Ohms ± 1%, 1/2 Watt, MIL type RN20R51R0F	V12 cathode resistor
R89	RESISTOR, fixed: film; 5600 Ohms ± 1%, 1/2 Watt, MIL type RN20R5601F	V12 plate resistor
R90	RESISTOR, fixed: film; 6800 Ohms ± 1%, 1/2 Watt, MIL type RN20R6801F	V12 plate resistor
R93,R102	RESISTOR, fixed: film; 1000 Ohms ± 1%, 1/2 Watt, MIL type RN20R1001F	Plate supply V13 voltage divider for audio output
R95,R100	RESISTOR, fixed: film; 300 Ohms ± 1%, 1/2 Watt, MIL type RN20R3000F	Cathode resistor V13
R96	RESISTOR, fixed: composition; 10,000 Ohms ± 10%, 2 Watt, JAN type RC40BF103K	V13 cathode resistor

TABLE OF REPLACEABLE PARTS

Reference Symbol	Name of Part & Description	Function or Location of Part
R98,R116	RESISTOR, variable: composition; 50,000 Ohms ± 10%, 1/4 Watt JAN type RV2ATSA503A	B+ adjustment Deviation meter adjustment
R97	RESISTOR, fixed: film; 220,000 Ohms ± 1%, 1/2Watt, MIL type RN20R2203F	Deviation crystal detector circuit
R99	RESISTOR, fixed: film; 4700 Ohms ± 1%, 1/2 Watt, MIL type RN20R4701F	V13 plate resistor
R101	RESISTOR, fixed: composition; 82,000 Ohms ± 10%, 1/2 Watt, JAN type RC20BF823K	Grid bias
R103	RESISTOR, variable: composition; 1,000 Ohms ± 10%, 1/4 Watt, JAN type RV2ATSA102A	Audio output level control
R105	RESISTOR, fixed: film; 40,000 Ohms ± 1%, 1/2 Watt, MIL type RN20R4002F	Deviation meter circuit
R106,R107	RESISTOR, fixed: composition; 10 Ohms ± 10%, 1 Watt JAN type RC30BF100K	B+ current limiting
R108	RESISTOR, fixed: composition; 65 Ohms ± 10%, 1 Watt, JAN type RC30BF650K	Load resistor V14
R110	RESISTOR, fixed: composition; 150,000 Ohms ± 10%, 1 Watt JAN type RC30BF154K	Voltage divides B+ regulator
R111	RESISTOR, variable: composition; 100,000 Ohms ± 10%, 1/4 Watt, JAN type RV2ATSA104A	Gain adjustment
R112	RESISTOR, fixed: composition; 100,000 Ohms ± 10%, 1 Watt JAN type RC30BF104K	Divides network B+ voltage regulator
R115	RESISTOR, fixed: composition; 82,000 Ohms ± 10%, 1 Watt JAN type RC30BF823K	

TABLE OF REPLACEABLE PARTS

Reference Symbol	Name of Part & Description	Function or Location of Part
R117	RESISTOR, fixed: composition; 51,000 Ohms ± 10%, 1 Watt JAN type RC30BF513K	Divides network B+ voltage regulator
R118	RESISTOR, variable: composition; 10,000 Ohms ± 10%, 1/4 Watt, JAN type RV2ATSA103A	Meter calibrating adjustment
R120,R122, R124,R126	RESISTOR, fixed: composition; 1,000 Ohms ± 10%, 1/2 Watt JAN type RC20BF102K	Grid bias
R127	RESISTOR, fixed; composition; 51,000 Ohms ± 10%, 1/2 Watt JAN type RC20BF513K	Grid bias
R128	RESISTOR, variable: composition; 1,000,000 Ohms ± 10%, 1/4 Watt, JAN type RV2ATSA105A	AVC Delay adjustment
I1	LAMP, incandescent; 6.3V, miniature bayonet General Electric Part No. 47	Indicates "POWER ON"
XI1	LIGHT, indicator; red frosted lens, w/o lamp, solder lug connections with mounting hardware, Dial Light Co. Part No. 81410-121	Holds I1
F1,F2	FUSE, cartridge; 2-1/2 amp 125 volts, MIL type MIL-F-15160A	Primary power protection
XF1,XF2	FUSEHOLDER, post: extractor; Bussman Mfg. Co. Part No. HKP-HBL	Holds F1 and F2
CR1	CRYSTAL DIODE; JAN type 1N21B	Mixer
CR2	RECTIFIER, selenium; voltage doubler, mounts by stud Radio Receptor Corp. Part No. Q13D1S5H	Rectifies B+
CR3,CR7	CRYSTAL DIODE; JAN type 1N69	

WARRANTY

The New London Instrument Company warrants each of its instruments to be free from defects in materials and workmanship. Our responsibility is limited to adjusting instruments and repairing or replacing defective parts (except tubes, fuses, batteries) for a period of one year after shipment when, in our opinion, such work is covered by this warranty. Warranty on tubes, fuses, and batteries depends on the warranty of the original manufacturer. The New London Instrument Company shall under no circumstances be liable for loss of profit or other damages.

SPECIFICATION CHANGES

The New London Instrument Company retains the right to discontinue any instrument without notice and to change specifications without responsibility for incorporating changes in instruments already sold.

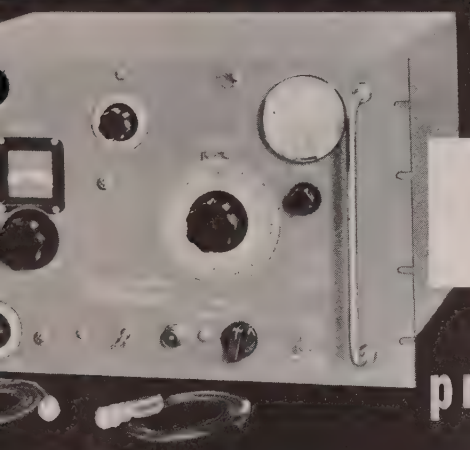
REPAIRS

The New London Instrument Company maintains stocks of repair and replacement parts. If the customer wishes to return an instrument for repairs, permission should be obtained from our factory or one of our accredited representatives.

In returning an instrument, the customer should state the difficulties experienced. Reference to specific parts, especially by circuit diagram designation, is always helpful.

NEW LONDON INSTRUMENT COMPANY, INC.

New London, Connecticut



NEW LONDON INSTRUMENT Company INC.

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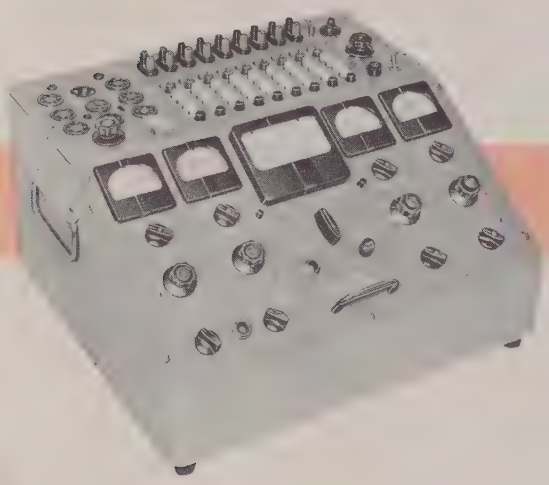
with "designed-in" accuracy,
simplicity, versatility

TRANSCONDUCTANCE ANALYZER and CIRCUIT DESIGNER Model 901A



SPECIFICATIONS:

0-50,000 micromhos in six ranges. Four continuously variable DC power supplies regulated to 1% for plate, screen, suppressor and grid. Plate supply 0-300V at 200ma.
AC and DC filament supply. Voltage controls direct reading.
Four multi-range current meters.

FEATURES:

Inherently stable calibrating circuit, ± 5% accuracy of GM measurement; convenient matrix of color coded push-button switches for rapidly connecting any electrode to any power supply. Binding posts with shorting links in series with each tube pin permit insertion of active and passive circuit elements and external metering. This feature replaces breadboarding of many vacuum tube circuits.

USES:

Performs transconductance, short, gas, VR, emission, leakage and noise tests. Facilitates rapid design of vacuum tube circuits. **$895.00***

TRANSISTOR MULTIMETER MODEL 400

SPECIFICATIONS:

Voltage Ranges (full scale):
At 200,000 ohms/volt DC and AC:
0.03, 0.1, 0.3, 1.0, 3.0, 10.0, 30.0, 100.0, 300.0, 1000.0

Ohms Midscale: 1, 10, 100, 1000, 10,000 100K, 1M

Accuracy: DC 2%, AC 3%

Frequency Response: AC voltmeter, 10 cps to 5 kc

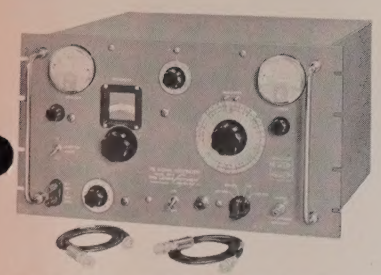
FEATURES:

This portable, highly sensitive, transistorized volt-ohmmeter is particularly adaptable for reading voltages as low as 1 millivolt with very high input impedance. The Model 400 can replace many non-portable VTVM's and VOM's opening new fields of measurement.
The use of transistors extends battery life to greater than 350 hours of continuous duty — direct reading of very low resistances eliminates the use of time consuming bridges **$140.00***

SIGNAL GENERATORS

NOISE SOURCES

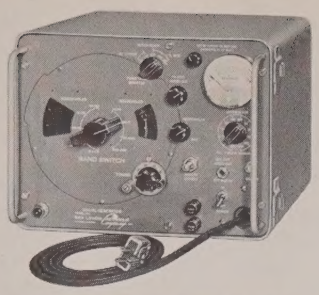
AMPLIFIERS & MODULATION MONITORS



FM SIGNAL GENERATORS SERIES 100

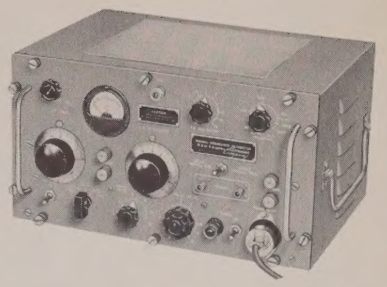
MODEL 100B-18 to 110MC. MODEL 100D-27 to 230 MC. Special designs up to 500MC. Deviation: 0-30KC and 0-250KC; **Accuracy:** ± 5% F.S. at 1000CPS also special ranges; **Distortion:** less than 2% at 100KC, much lower available to special order; **Output Voltages:** 0.02 to 100,000 microvolts using two terminated cables; Precision piston attenuator ± 10% accurate; **Features:** Low leakage, distortion, drift and spurious output.

Standard models $885.00*



AM SIGNAL GENERATOR MODEL 162

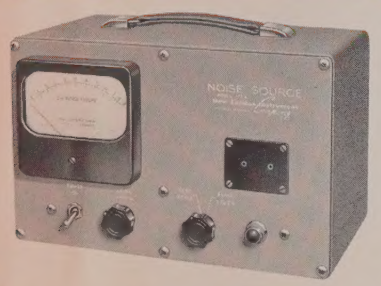
Frequency Range: 10KC to 50MC in 9 bands; **Frequency Calibration Accuracy:** ± 0.5%; **Internal Modulation:** 400 and 1,000CPS, 0 to 50% mod.; **External Modulation:** 0 to 80%, up to 15KC mod. frequency; **Output Voltages:** Var. 0.1 to 100,000 microvolts at 50-ohms and 1 volt at 500-ohms. **Attenuator:** Ladder & variable pad, 10% accuracy; **Distortion:** Less than 7% at 50% mod.; **Features:** Built-in crystal calibrator, negligible FM, drift & leakage. A highly portable unit. **$515.00***



SIGNAL GENERATOR MODEL TS155

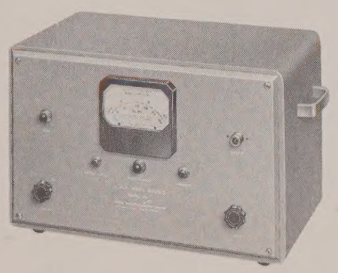
Frequency Range: 2700-3400MC in three ranges; **Output:** —20 to —100 dbm at 50-ohms using piston attenuator; **Modulation:** Pulse internal or external trigger —95 dbm; **RF Pulse Shape:** Rise: less than .35 μsec; **Duration:** 0.7 to 12 μsecs ± 10%, flatness 5%; For testing of pulse receivers and transmitters. Thermistor bridge can be connected to directly measure incoming rf power up to 200MW.

$1200.00*



UHF-VHF NOISE SOURCE MODEL 175A

Frequency Range: 50 to 900MC; **Noise Figure:** 0 to 19db; **Accuracy:** ± 0.5db below 400MC, ± 1db max at 900MC when using 300-ohm equipment; **Output Impedance:** Designed for 300-ohm balanced loads; **Features:** Quickly measures noise figure and gain of TV & FM tuners & receivers. Reads directly in db. No balun required; Long life, inexpensive noise diodes; No tuning required. **$285.00***



UHF NOISE SOURCE MODEL 191

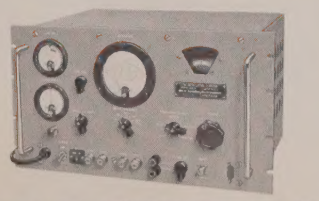
Frequency Range: 3 to 3000MC; **Noise Figure:** 0 to 20 db; **Output Impedance:** 50-ohms unbalanced; **Meter Calibration:** Linear in db; **Filament Voltage:** Highly regulated; **Features:** Measures noise figure & gain of receivers; calibrates signal sources; low VSWR; no tuning required; automatic cut-off prolongs diode life. Smith chart supplied. **$750.00***

RANDOM NOISE SOURCE MODEL 403

Frequency Range: 3 to 500MC; **Noise Figure:** 0 to 19db direct reading; **Accuracy:** ± ½ db over entire frequency range; **VSWR:** below 1.3 over entire frequency range; **Output Impedance:** 50-ohms unbalanced; **Features:** Measures noise figure, bandwidth & gain of receivers, calibrates signal sources; high accuracy; low VSWR; long life, inexpensive noise diodes; no tuning required. **$285.00***

BROADBAND AMPLIFIER MODEL 160

Frequency Response: 15KC to 50MC (3db points); **Gain:** 60db into 1000-ohm load. Cont. var. over 20db range; **Output:** 18 volt p-p into 1000 ohms; **Rise Time:** .010 microseconds; **Impedances:** Input—nominally 1000 ohms; Output—1000 ohms; **Features:** For general purpose lab work; amplifies low-level counter pulses; increases sensitivity of oscilloscopes and voltmeters; facilitates ultrasonic delay line measurements; used as post amplifier in noise measurements. **$290.00***



FM MOD. MONITOR MODEL 257A

Carrier Frequency Range: 20 to 1000MC in 5 bands; **Deviation Ranges:** 0 to 1000KC in 5 bands, direct reading; **Deviation Accuracy:** ± 5% for 0 to 200KC & ± 10% for 200 to 1000KC deviations; **Input Sensitivity:** Better than 10MV from 20 to 500MC, 20MV from 500 to 1000MC; **Audio Frequency Response:** ± 1 db from 50 to 70,000CPS; **Uses:** Measuring frequency deviation, carrier noise, hum & Mod. distortion of transmitters & signal generators. Measuring FM of AM transmitters. Monitoring TV, FM & telemetering transmitters. **Features:** Wide RF and deviation range; wide audio response; low internal hum, noise & distortion; insensitive to 30% spurious AM. **$2400.00***

AM MOD. MONITOR MODEL 252

Frequency Range: 100-225 or 225-400MC or special ranges; **Modulation Range:** 0 to 100% positive or negative; **Accuracy:** ± 2% at 0% & 100% mod. of 1000CPS; ± 4% at other values; **Overmodulation Indicator:** Flashing light indicates modulation over pre-set value; **Audio Monitoring Output:** Approx. 1V across 600-ohms, response 20-45,000CPS ± 1 db; **Fidelity Measuring Output:** Approx. 10V across 0.1 meg. response 20-30,000CPS ± 1 db; **Features:** Direct accurate reading; overmodulation indicator; low noise and distortion; output monitoring circuit **$750.00***

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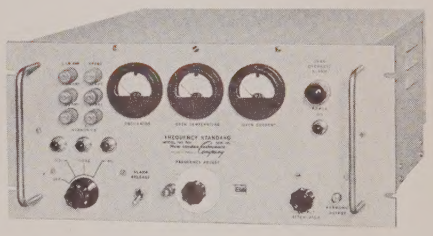
FREQUENCY STANDARDS & ATTENUATORS

RF ATTENUATOR MODEL 462

Frequency Range: DC to 125MC; **Attenuator:** 0 to 110db in 10db steps; **Accuracy:** ± ½db; VSWR: 1.2 at 125MC; **Impedance:** Source & output — 50-ohms; att. input — 150-ohms; **Features:** Ladder type, step attenuator with 12 position switch; minimum leakage due to heavy cast construction. Convenient compact size for production and laboratory applications. Available in special ranges & as your equipment component.

$59.00*

FREQUENCY STANDARD MODEL 701



Crystal Oscillator Frequency: 1MC; **Output Frequencies:** 10 to 50MC at intervals of 10KC, 100KC and 1MC; **Output Voltage:** 200 microvolts into 50-ohms up to 20MC; 10 microvolts into 50 ohms up to 50MC; 2 volts into 50 ohms with 100KC sine wave, no attenuator; **Frequency Stability:** After 48 hours of continuous operation (1) 1 part in 10^7 per 24 hours (2) 1 part in 10^7 for ± 10% line voltage change, (3) 1 part in 10^8 per degree Centigrade; **Features:** Excellent source of highly stabilized frequencies. For nuclear resonance measurements and determination of crystal frequencies.

$1485.00*

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